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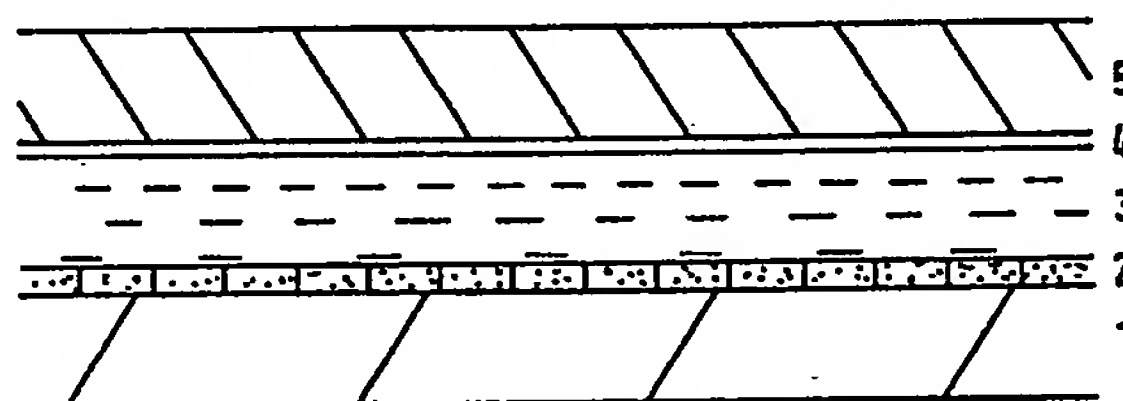
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(54) **Photosensitive stencil materials.**

(57) Stencil materials for use in screen printing are multi-layer products, having a film support (1) which carries two or more light-hardenable layers (2; 3) and a peelable cover sheet (4, 5); the layer 3 in contact with the cover sheet (4, 5) has a sufficient thickness and also is sufficiently soft and tacky to be able to absorb the meshes of a printing screen at least to an extent to allow the stencil material to adhere to the screen; the layer 2 nearer the support (1) is relatively harder and non-tacky.



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1 PHOTOSENSITIVE STENCIL MATERIALS

5 This invention relates to photosensitive stencil materials for use in screen process printing and particularly concerns precoated stencil film materials and their methods of use.

10 In screen printing, the printed image required is defined by a negative of the image carried upon a screen printing cloth, which is usually in the form of a woven polyester or steel fabric. The invention provides improved methods and materials for producing screen printing stencils photographically and offers advantages both in production and use of such stencils, when compared with any of the four methods commonly used. These known techniques can be characterized as the direct, indirect, 15 direct/indirect and capillary methods and are described briefly below. The invention may be termed a pressure-bonded method and is described in detail further below.

20 In the direct coating method, photostencils are produced by coating a light-sensitive composition, known as a direct emulsion, directly upon the stencil screen and, after drying, exposing the coated screen through a photographic positive. The exposed photostencil is then developed by washing away the un-exposed areas in water, leaving the insoluble exposed areas in the form of a 25 negative image which adheres firmly to the screen,

1 the mesh being encapsulated by the emulsion during
the coating process. Direct emulsions are usually composed
of mixtures of polyvinyl alcohol and polyvinyl acetate, post-sensitised
with a dichromate salt or a water-soluble diazo resin,
5 these emulsions cannot be supplied in a pre-sensitised form,
due to shelf-life considerations. Some pre-sensitised
direct emulsions based on alternative photochemistry
are known, which eliminate the need to sensitise the
emulsions before use. The main advantage of stencils
10 produced by the direct coating method is their
durability, while their use can also be comparatively
economical, depending upon the materials and the details
of the production methods employed. Their main dis-
advantages are inconsistency in thickness and difficulty
15 in eliminating the mesh pattern from the edges of printed
images. Unless considerable time and care are taken
in the coating step, direct photostencils are unsuitable
for applications where high resolution, absence of edge
defects and close ink deposit control are important.

20 A variation of the direct coating method is also
known, in which the positive is laminated to the screen
with a photosensitive emulsion or lacquer during the
coating operation, such as is described in GB-A-2002531.
However, this method has not found wide commercial use,
25 because of inherent disadvantages, such as contamination
of photographic positives and exposure equipment by the
liquid photopolymer and difficulty in removing stencils
from the screen-fabric after use.

In comparison with the direct method, the other
30 known methods for producing screen photostencils employ
precoated film materials and generally provide greater
consistency, better ink deposit control and higher
potential image quality.

In the "indirect" method, a sub-coated transparent
35 plastics support, usually polyester film, carries a

1 pre-sensitised polymer layer. For instance, coatings
based upon polyvinyl alcohol sensitised with a monomer/
photoinitiator are described in GB-A-1307995. In use,
a photographic positive is placed between a light source
5 and the polyester support, so that exposure of the
photosensitive coating is made through the transparent
support. The unexposed areas remain soluble in the
developer, which is usually water, so that the resultant
negative resist image of the original remains attached
10 to the polyester support. In order to prepare for
printing, a moistened screen is contacted with the stencil,
which is then dried and the film or other support is
peeled away.

The indirect method is particularly suitable for
15 high-resolution printing, where good definition is
important and where close ink deposit control must be
maintained. However, indirect stencil materials lack
durability, due to the relatively weak bond between the
stencil and the screen mesh, caused by hardening of the
20 coating before it comes into contact with the mesh.

The need for photostencil systems which combine
the durability of those made by the direct method with
the reproducibility and image quality of those made by
the indirect method led to the development of the so-
25 called direct-indirect stencil system, such as described
in US-A-3532052. A dry coating of a non-photo-sensitive
resist layer on a support sheet is laminated with the
printing surface of a screen using a photo-sensitive
emulsion, which encapsulates the mesh and so firmly
30 attaches the coating, still carried on its support, to
the screen. After drying, the support sheet is peeled
away, leaving a flat even printing surface of constant
and reproducible thickness on the screen. These stencils
have the advantages mentioned, but their main dis-
35 advantages are the complex processing involved in their

1 use and the need for sensitising by the user. With most
direct-indirect coated materials, the sensitizer migrates
into the film material from the laminating emulsion. The
amount of emulsion used for the laminating stage and the
5 drying time are two of a number of variables governing
the amount and distribution of sensitizer in the coated
film. Even if procedures are carefully standardised,
climatic conditions and variations in operator technique
are additional factors which adversely affect the
10 reproducibility of stencils. In the production of high-
quality durable thick stencils, the direct-indirect method
and materials have enjoyed considerable commercial success,
even though existing materials involve tedious processing
and give variable results, particularly when the slower
15 migrating diazo-resin sensitizers are used in conjunction
with coatings of more than 25 μ thickness.

Capillary film materials use a presensitized dry
resist coating, which is prepared by attachment to a
printing screen using water, drying the coating, removing
20 the carrier film and exposing in conjunction with a master
positive. As there is no sensitising step and no need to
handle chemicals or apply an emulsion coating, much of
the tedious processing of the direct-indirect system is
eliminated and capillary stencil methods and materials
25 provide the best available combination of image quality,
durability and reproducibility. The versatility of the
capillary method is also high, as films are available in
a wide range of coating thicknesses to suit a wide
variety of mesh counts, and capillary materials also are
30 available which are resistant to water-based inks, as well
as those resistant to conventional solvent-based inks. At
present, however, separate films must be used for these
two applications.

In order to illustrate the state of the art in
35 stencil production, the processing steps involved in the

- 1 use of a capillary product, Capillex 35 (Regd. Trade Mark of Autotype International Ltd) are described below; this product is a precision-coated diazo-resin-sensitised polyvinyl alcohol/polyvinyl acetate emulsion, containing minor proportions of additives; the dry
- 5 coating has a thickness of 33-36 μ and its support is 75 μ guage biaxially-oriented polyester film.

Preparation of Stencil attached to a Polyester Fabric Screen

- 10 (1) The screen is first thoroughly cleaned, so that the mesh fabric can hold a uniform film of water without showing signs of repellancy;
- (2) The Capillex 35 film is unrolled and cut to size under "light-safe" conditions, namely in an area substantially free from ultra-violet, blue or green light;
- 15 this is conveniently achieved by operating under yellow fluorescent illumination, with the elimination of sunlight;
- (3) The film is rolled around a tube, with the emulsion side out, its leading edge is contacted with the top of the
- 20 wet screen and the rest of the film is then unrolled across and in contact with the screen; as the emulsion is partly dissolved and sucked into the mesh by capillary action, the coating becomes firmly attached;
- (4) The screen is then dried, preferably in a warm air
- 25 stream, and the backing film is then peeled away;
- (5) The screen is then exposed to a photographic positive in a vacuum printing frame for the required period of time (usually 2-10 mins, depending on the power and type of light source and its distance from the frame);
- 30 (6) After exposure, the stencil is washed with water to dissolve unhardened (unexposed) emulsion, leaving firmly adhered to the mesh a negative image of the photographic positive;
- (7) The stencil is then dried and any open areas of mesh
- 35 surrounding the image are blocked out with a screen filler;

1 the stencil is then ready to be mounted on a press
for printing.

These seven steps just described show readily
that stencil preparation even using the convenient
5 capillary method is still relatively time-consuming
and tedious, despite the fact that this method is the
fastest and most reliable way at present to prepare
durable high-quality printing resists. Moreover,
the capillary technique, in common with direct emulsions,
10 indirect films and direct/indirect films, does not allow
the production of stencil resists which are suitable
for all types of printing ink. Most stencil materials
have good resistance to the organic solvents typically
used in screen printing inks, e.g. aliphatic and aromatic
15 hydrocarbons, alcohols, esters and ketones, but do not
have good resistance to water-containing inks; mixtures
of organic solvents and water are particularly damaging
to conventional stencil materials. An exception to this
is given by those photostencils which derive their solvent
20 and water resistance from post-hardening treatments, such
as baking or lacquering; these stencils are very durable
but their use is normally confined to textile printing
operations, as the curing operation is specialised and
time-consuming and, moreover, these stencils cannot be
25 removed from the mesh after use, giving the serious
disadvantage that the expensive screen cloth cannot be
re-used.

There is thus a distinct need for a new type of
screen photostencil material, which is quicker, simpler
30 and more versatile than those employed in the known
methods briefly described above and which yields stencils
suitable for use with solvent-based, solvent/water-based
and water-based inks. It is an object of this invention
to fulfil this need.

35 According to the present invention, a photosensitive

1 stencil material is provided, which is in the form of a
multi-layer product which is characterised by comprising
a transparent plastics film support carrying at least two
superposed light-hardenable layers and a cover sheet upon
the light-hardenable layer furthest from the support,
5 wherein the light-hardenable layer in contact with the
cover sheet is at least sufficient in thickness to
embed at least partially an applied screen printing mesh,
when in use, and is more soft and tacky than the
underlying light-hardenable layer nearer the film support,
10 which is relatively harder, substantially non-deformable
and non-tacky.

The substantially non-deformable and non-tacky
layer serves in use to provide a flat printing surface
at the interface between the stencil and the substrate
to be printed and ensures that this flat surface is
15 obtained mainly by limiting reception of the screen
printing mesh to the more soft and tacky layer, which
is exposed when the cover sheet is removed and the
screen is brought into contact with the multilayer stencil
material of the invention. This therefore provides even,
20 i.e. uniform, reproducible ink deposits and sharply-defined
printed images. It has been found that provision of the
substantially non-deformable layer ensures that printed
images of good quality can be obtained over a range of
25 mesh counts. It has also been found that the products
needed for an alternative system, having a single
pressure-sensitive layer of a photocurable composition
on a support, are difficult to store and handle, because
they have a tendency toward edge seepage and coating
30 deformation.

According to a preferred feature of the stencil
material of the invention, two relatively hard substantially
non-deformable and non-tacky layers are provided between
the film support and the light-hardenable layer which is
35 in contact with the cover sheet, either or both of such

1 relatively hard, substantially non-deformable and non-tacky layers comprising a light-hardenable composition.

Preferably, the plastics film support comprises a material selected from polyesters, polyvinyl chloride, 5 polycarbonates and polystyrene.

According to another preferred feature of the invention, the light-hardenable layer in contact with the cover sheet comprises polyvinyl pyrrolidone, pentaerythritol triacrylate, while the underlying 10 light-hardenable layer comprises polyvinyl alcohol.

In order that the invention may be readily understood, three embodiments are described below, by way of example only, in conjunction with the accompanying 15 drawings, in which:

Fig. 1 shows diagrammatically, in section, a first embodiment of a multilayer stencil material according to the invention;

Fig. 2 shows another embodiment of the invention, again diagrammatically and in section; 20

Fig. 3 shows a further embodiment of the invention, also diagrammatically and in section.

Referring to Fig. 1, a transparent plastics film support 1 is coated on one side with a layer 2 of a 25 flexible, but not easily deformable, light-hardenable composition. This layer 2 has over it a second coating layer 3, which consists of a soft relatively-deformable photo-sensitive and adhesive composition. The layer 2 is therefore also light-hardenable and additionally is 30 relatively harder than the layer 3 and also is substantially non-deformable. In terms of their softness and tackiness, the layer 3 is more soft and more tacky than the layer 2, which is comparatively non-tacky. Finally, a release or cover sheet 4, 5 is laminated on 35 to the otherwise exposed surface of the pressure-sensitive

1 photocurable adhesive layer 3. This cover sheet 4,5
consists of a paper or plastics film layer 5 coated
with a release layer 4, the release layer 4 being the
component in contact with the adhesive layer 3. The
5 stencil material thus comprises the support 1, the two
light-hardenable layers 2 and 3 and the cover sheet
4,5.

Referring to Fig.2, this shows an embodiment in
which the film support 1, the relatively soft and tacky
10 photohardenable layer 3, the release layer 4 and the
paper film layer 5, the two latter comprising the peelable
cover sheet 4,5, are essentially the same as in the
embodiment of Fig.1. Two separate relatively hard and
non-tacky layers 2a and 2b, either or both of which
15 may be a photocurable composition, underlie the
photocurable layer 3. The layer 2a may be a photosensitive
or non-photosensitive sub-coat.

The transparent plastics film support 1, in any
form of the stencil material of the invention, can be
20 any of several suitable film materials, such as polyesters,
polyvinyl chloride, polycarbonates and polystyrene. The
film support 1 is preferably a material which is
substantially transparent to light in the wavelength
band of 350-450 nm, because photo-initiators used in
25 photohardenable layers are activated by light in this
spectral region. Preferably, the transparent film
support 1 has a thickness in the range from 0.2×10^{-1} mm
to 1.3×10^{-1} mm (20-130 μ). It has been found that thinner
supports are usually less than satisfactory, because
30 they often give rise to handling difficulties, while
thicker supports may cause loss of resolution during
exposure. The cover sheet 4,5 may be a plastics
film or paper 5, treated to prevent it adhering too
firmly to the pressure-sensitive photopolymerisable
35 layer 3, by application of the release coating 4.

1 The thickness of the various photohardenable
 layers, such as the layers 2, 2a and 2b or 3 in the
 embodiments of Figs. 1 and 2, can be varied over wide
 limits. In fact, it is an advantage to vary the
 5 thickness of the layers, that is to provide a range
 of materials in which these layers are of different
 thicknesses, in order to adapt the stencils better for
 specific printing applications. The relatively soft
 adhesive photohardenable layer 3 may have its thickness
 10 regulated so as to make the resultant product more
 suitable for adhering to very coarse, coarse, medium,
 fine and very fine meshes, respectively. Generally,
 very coarse meshes are taken to be those having a
 thread count below 30 threads/cm; coarse meshes have
 15 30-60 threads/cm; medium meshes have 60-110 threads/cm
 and fine meshes have 110-165 threads/cms. Any mesh
 having more than 165 threads/cm can be classified as very
 fine. Preferably, the stencil materials of the invention
 are made so that the light-hardenable layer in contact
 20 with the cover sheet has a thickness equal to at
 least half the cross-sectional thickness of a selected
 one of the five categories of stencil screen printing
 meshes represented by:

25	very coarse:	5 to 2.5×10^{-1} mm	(500 to 250 μ)
	coarse:	2.5 to 1×10^{-1} mm	(250 to 100 μ)
	medium:	10 to 6×10^{-2} mm	(100 to 60 μ)
	fine/very fine:	8 to 5×10^{-2} mm	(80 to 50 μ)

30 whereby the stencil material can be used with screen
 printing meshes of the selected category and finer
 categories. The dimensions given for the various
 categories are the thread thicknesses corresponding to
 the respective thread counts.

35 In order to adhere the laminated screen stencil

1 materials of this invention to the screen mesh, it is
necessary partially to encapsulate the mesh with the soft
adhesive photohardenable layer 3 of the product, which is
exposed when the cover sheet 4,5 has been removed.
5 Complete encapsulation is not necessary, but to ensure
good adhesion of the stencil material to the mesh
during printing, it has been found, as a general rule,
that the mesh should be embedded to at least half its
cross-sectional thickness, so as to ensure optimal
10 adhesion. It will be understood from the foregoing
that it is possible to vary considerably the thickness
of the soft adhesive layer 3, so as to enable the
stencil material to be optimised for use with the various
categories of meshes described. Alternatively, a single
15 product can be formulated and made, which is capable of
encapsulating all classes of mesh, but, when such a
product is used with medium and fine meshes, it is
usually necessary to protect the vacuum blanket of the
printing-down frame, during exposure, from contamination
20 by the soft tacky photohardenable layer 3, which flows
around the back of the screen threads under vacuum pressure.
A further disadvantage of providing and of using one
product for all categories of meshes is represented by
the prolonged exposure times which are needed to photo-
25 harden very thick adhesive layers, which is an unnecessary
inconvenience if medium or fine meshes are being used.
In practice, a product with a photohardenable adhesive
layer of approximately $5 \text{ to } 6 \times 10^{-2} \text{ mm}$ (50-60 μ) works
well with medium, fine and very fine meshes; for coarser
30 meshes the products are preferably made with adhesive
layers which are progressively increased in thickness as
necessary, to ensure sufficient mesh encapsulation for
good stencil adhesion to be obtained.

The flexible, but non-deformable layer 2, in Fig. 1,
35 or layers 2a, 2b in Fig.2, may also have its or their

1 thickness varied between wide limits. By varying the
thickness of the photohardenable non-deformable layer 2
or 2a, 2b, the relief or height of the stencil
protruding from the mesh can be varied. Since the tacky
5 photohardenable layer 3 embeds the mesh, the flat
printing surface, necessary to ensure that lateral
ink flow under the stencil edges does not occur, is
provided by the photohardenable non-deformable layer
2 or 2a, 2b, which sits proud of the mesh. Fig. 3
10 shows a schematic cross-sectional view of a monofilament
screen mesh with a photohardened and developed stencil
adhered to it. The layer 6 of the stencil represents
the flexible non-deformable component which constitutes
the printing surface and the layer 7 is the photohardened
15 adhesive layer into which the mesh 9 is embedded. The
height of the layer 6 above the mesh 9 can be varied
between a few microns and several hundred microns. The
thickness of the layer 6 has a direct influence on the
amount of ink or other screen-printable substance
20 deposited when the distance, 8, representing a typical
stencil opening, is not greater than about 3 mm. For
some screenprinting applications, it is necessary to limit
the ink deposit as much as possible, in which case the
thickness of the layer 6 is preferably not greater than
25 1×10^{-2} mm (10 μ) as is normally the case in commercial
half-tone colour printing. For other applications, such
as the printing of solder-masks during printed circuit
board manufacture, the layer 6 can advantageously be
3 - 5 $\times 10^{-2}$ mm (30-50 μ) in thickness; in the printing
30 of solder pastes in thick-film circuit board production,
the layer 6 can advantageously be $1 - 5 \times 10^{-1}$ mm
(100 - 500 μ) in thickness.

The laminated photosensitive multilayer stencil
materials of the invention are used to prepare printing
35 screens as follows:

1 A sheet of the laminated screen stencil film
material of the appropriate size, which is somewhat
smaller than the printing area of the screen mesh,
but larger than the photographic positive to be exposed,
5 is taken. One of its top corners is adhered to the mesh
by peeling away the protective cover sheet and pressing
the exposed part of the soft and tacky coating lightly
into the mesh. The screen should be dry, but does not
need to be specially prepared or cleaned. New (virgin)
10 screen mesh may be used without any special pretreatment
or degreasing procedure.

 The protective cover sheet is then stripped away
and the stencil film material is smoothed into contact
with the screen mesh by hand. At this stage, the stencil
15 film is not firmly adhered. If a printing-down frame
equipped with a flexible rubber blanket is used to carry
out the exposure to the photographic positive, then the
pressure generated in the frame is sufficient to push the
adhesive layer into the screen mesh and hence firmly
20 adhere the stencil. If a vacuum frame is not used, then
the stencil film can be adhered by ironing the stencil
on to the mesh with a warm iron (50° - 120°C). If the
stencil is ironed from the inside of the screen frame
(squeegee side), then the release-coated cover sheet 4,5
25 should be placed on the mesh, so as to prevent any direct
contact between the iron and the adhesive coating.

 Exposure is advantageously carried out using a
mercury halide, mercury vapour or carbon arc light
source, the time varying with the radiation flux incident
30 on the stencil, which in turn is a function of light
intensity and distance. Exposure times similar to and
faster than conventional screen stencil materials are
readily obtained. After exposure, the plastics backing
sheet or film support is stripped off the exposed stencil.
35 It is possible to formulate the photohardenable coatings

1 so that, on stripping off the backing sheet, unexposed
areas of the stencil are stripped away from the screen
mesh simultaneously, thereby enabling a dry-developed
5 stencil to be provided. Alternatively, the backing sheet
can be stripped away leaving all of the coating still
adhered to the mesh and the unexposed areas are then
washed away with water. Whichever method is preferred,
the resultant stencil can be water-proof and solvent-
10 resistant and can be used to print a wide variety of
solvent-based and water-based screen inks.

The photostencil materials of the invention can
be readily formulated so as not to be sensitive to
normal diffuse daylight and white light from fluorescent
tubes, yet can have very short exposure times using the
15 standard light sources used with photoresist coatings.
This enables screens to be prepared without the need to
work in safelight conditions, which all conventional
screen stencil materials require. This is a significant
advantage for small printing shops which do not have
20 sufficient space to provide segregated stencil production
areas.

In summary, the screen stencil materials of the
invention offer significant advantages over all of the
four classes of conventional materials described above.
25 Their ability to adhere to dry screens, without the
necessity for degreasing and roughening the mesh,
substantially speeds up screen make-ready times. Their
ability to adhere by vacuum contact or a quick smoothing
with a warm iron eliminates the tedious mounting and
30 drying procedures required when using conventional
direct, direct-indirect and capillary stencil materials.
The possibility of providing self-developing materials
by peeling out unexposed areas with the backing sheet
is a very significant advance in ease of handling and
35 speed of stencil production. Materials according to the

1 invention which are developed with water can be dried
simply by wiping with an absorbent cloth, due to the
robust and resilient nature of the stencils produced,
thus substantially eliminating the post-development
5 drying procedure required by all the main categories
of photo-stencil materials of the prior art. Moreover,
the stencils produced using the invention can readily
be formulated to be both water-resistant and solvent-
resistant, which once again is not normally the case
10 for conventional stencil materials.

In order that the invention may be readily
understood, some practical Examples of photosensitive
multi-layer stencil materials embodying the invention
are described below, by way of illustration only.

15 In these Examples, various commercially-available
materials are listed by their trade names or their
registered trade marks; the lower case Roman numbers
given after these product names identify the following
companies:

- 20 (i) Nippon Gohsei, Osaka, Japan
(ii) Vinyl Products Ltd, Mill Lane, Carshalton, Surrey,
England.
(iii) BASF, P O Box 4, Earl Road, Hulme, Cheadle, Cheshire,
England.
25 (iv) Ciba-Geigy, Paisley, Renfrewshire, Scotland.
(v) G.A.F. (Great Britain) Co. Ltd, Tilson Road,
Wythenshawe, Manchester, England.
(vi) Industrial Minerals Corporation, Ghent, Belgium.

30 Example 1 describes a range of products which
illustrate the effect on adhesion of a variation in
thickness of the soft and tacky photohardenable layer
3, while Example 2 describes a range of products which
illustrate the effect on stencil relief on the screen
35 mesh of a variation in the thickness of the relatively

1 hard and non-deformable layer 2.

EXAMPLE 1

(a) Substantially non-deformable layer 2:

% W/W

	Polyvinyl alcohol - "Gohsenol" KH 20 (i)	3.30
5	(80% hydrolysed)	
	Polystyrene (50% aqueous dispersion)- "Vinamul" 7700 (ii)	4.20
	Polystyrene (55% aqueous dispersion)- "Vinamul" 8440 (ii)	8.20
	Acrylated polyurethane (55% aqueous dispersion)	
10	- "Laromer" PE55W (iii)	32.80
	Isopropylthioxanthone	0.60
	Ethyl-paradimethylaminobenzoate	2.40
	Water	47.90
	Aqueous dispersion of dioxazine pigment -	
15	"Unisperse" Violet BE (iv)	0.60

The polyvinyl alcohol is dissolved in the water with heating, under the action of a high shear stirrer. When a completely homogeneous solution is obtained, it is allowed to cool to 30°C and all the other ingredients are then added and slowly stirred in, until the mix is again completely homogeneous.

(b) Substantially soft and tacky layer 3:

% W/W

	Polyvinyl pyrrolidone - K90 (v)	5.50
	Pentaerythritol triacrylate	42.00
25	Industrial methylated spirit (IMS)	36.40
	Diethoxyacetophenone - "Irgacure" 651 (iv)	0.15
	Talc - "Mistron Monomix" (vi)	15.80
	Triethanolamine	0.15

The pentaerythritol triacrylate, "Mistron Monomix" and the polyvinyl pyrrolidone are added to the IMS and these ingredients are mixed using a high shear stirrer until fully homogeneous. The mix is then allowed to cool to 30°C. The other ingredients are then added and the mix is slowly stirred until it is again completely homogeneous.

35 A coating of component (a) followed by a coating

1 of component (b) were applied, using wire wound rods
(see Table 1, to a transparent film support, such as that
shown at 1 in Fig.1, comprising a 5×10^{-2} mm thick
"Melinex" polyester film (I.C.I.) Drying of the coating
5 was carried out using 40°C warm air.

The resultant series of coated films were then
laminated to 72 g/m² kraft paper polythene-coated on
one side and silicone-treated on the polythene side,
serving as the release-coated cover sheet (4/5 in Figs.
10 1 and 2).

The range of stencil film materials so manufactured
were then used, by being applied to screen printing
meshes by the technique described above, by peeling away
the silicone-coated release backing paper (4/5) and
15 applying the exposed soft and tacky layer (3) to the mesh
fabric. With the aid of smooth hard pressure, the film
materials were adhered by thus causing the layers (3)
to penetrate the mesh.

Photographic exposure of the films was accomplished
20 using a 3 kW "Nu-Arc" Fliptop unit with a mercury halide
lamp. A vacuum frame held the photographic positive
in contact with the polyester support (1). The siliconised
backing sheet (4/5) removed in applying the films to the
screens can be used to prevent any tackiness at the back
25 of the mesh from spoiling the vacuum blanket.

After exposure, the screen is removed from the
exposure unit and the backing sheet (4/5) is removed if
still adhering. The polyester support (1) is peeled
away from the surface of the film and the film is washed
30 thoroughly with cold or warm water, until all unexposed
areas of the stencil film are removed. The finished
stencil film may then be dried with either a warm fan
or by wiping with a cloth prior to use.

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Mesh Size (Threads/cm)	40	73	90	120
Thickness of Layer 2 (10 ⁻³ mm)	9 8 9	8 9 9	9 10 9	9 9 8
Wire Wound Rod mm (10 ⁻³ in)	0.63 (25)	0.63 (25)	0.63 (25)	0.63 (25)
Thickness of Layer 3 (10 ⁻³ mm)	61 72 87	25 49 73	17 35 41	6 19 25
Wire Wound Rod mm (10 ⁻³ in)	1.52 1.77 2.03 (60) (70) (80)	0.76 1.14 1.77 (30) (45) (70)	0.50 0.89 1.02 (20) (35) (40)	0.25 0.50 0.76 (10) (20) (30)
Stencil Relief (10 ⁻³ mm)	9.2 16.6 30.6	11.7 15.0 33.8	10.8 12.4 17.5	9.2 13.2 15.6
Film Penetration into Mesh (%)	90 100 100	50 100 100	50 100 100	75 100 100
Thickness of layer 3 to enclose mesh	65	45	33	14
Performance Rub resistance to 50/50 cyclohexanone/ 2-ethoxyethanol and 80/20 water/2- butoxyethanol.	All films very hard and resistant to solvents and solvent/water blends.	Stencil with 25 x 10 ⁻³ mm of layer (3) washed off mesh, other all very hard and resistant to solvents and solvent/water blends.	Stencil with 17 x 10 ⁻³ mm of layer (3) washed off mesh, others all very hard and resistant to solvents and solvent water blends.	Stencil with 6 x 10 ⁻³ mm of layer (3) gave poor solvent/water resistance and was easily damaged, others performed well.

Table 1 shows that the meshes which were completely enclosed were well adhered and showed a rugged nature in use and were extremely resistant to soaking and subsequent rubbing with the solvents and solvent/water blends commonly used in screen inks, i.e. cyclohexanone, 2-ethoxyethanol and 2-butoxyethanol.

Where the meshes were not totally encapsulated with the stencil film layer (3), adhesion to the mesh suffered, resulting in stencil damage, this effect becoming more pronounced as the mesh encapsulation decreased.

EXAMPLE 2

The formulations of the non-deformable and tacky layers (2) and (3) were as in Example 2.

Table 2 shows the effect of a variation in the thickness of the layer (2) in the film material, when applied to a 40 threads/cm polyester mesh. Coating, drying, laminating, exposure and water wash-out of the stencil films were carried out as in Example 1.

TABLE 2

THICKNESS (X 10^{-3} mm)	STENCIL HEIGHT ABOVE MESH	EXPOSURE UNITS	ASSESSMENT OF PENETRATION INTO MESH
LAYER 2 LAYER 3			
- 45	5.0	30	80%
3 36	7.7	30	60%
10 35	13.6	30	60%
14 35	17.0	30	60%
24 35	23.0	45	60%

From Example 1 it can be seen that approximately 65×10^{-3} mm of film thickness (3) was required to enclose fully the 40 threads/cm mesh. A considerably reduced thickness of layer (3) was purposely chosen, in order to illustrate the effect upon stencil relief of a variation in the thickness of layer (2).

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1 Table 2 clearly shows the comparable stencil
relief obtained for a given thickness of layer (2)
and the use of this layer for controlling the stencil
relief.

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1 CLAIMS

1. A photosensitive stencil material, in the form of a multi-layer product, characterised by
 5 comprising a transparent plastics film support carrying at least two superposed light-hardenable layers and a cover sheet upon the light hardenable layer furthest from the support, wherein the light-hardenable layer in contact with the cover sheet is sufficient
 10 in thickness to embed at least partially an applied screen printing mesh, when in use, and is more soft and tacky than the underlying light-hardenable layer nearer the film support, which is relatively harder, substantially non-deformable and non-tacky.

15 2. A stencil material according to claim 1, wherein two relatively hard substantially non-deformable and non-tacky layers are provided between the film support and the light-hardenable layer which is in contact with the cover sheet, either or both of such relatively
 20 hard, substantially non-deformable and non-tacky layers comprising a light-hardenable composition.

3. A stencil material according to claim 1 or 2, wherein the light-hardenable layer in contact with the cover sheet has a thickness equal to at least half the
 25 cross-sectional thickness of a selected one of the five categories of stencil screen printing meshes represented by:

30	very coarse:	5 to 2.5×10^{-1} mm	(500 to 250 μ)
	coarse:	2.5 to 1×10^{-1} mm	(250 to 100 μ)
	medium:	10 to 6×10^{-2} mm	(100 to 60 μ)
	fine/very fine:	8 to 5×10^{-2} mm	(80 to 50 μ)

whereby the stencil material can be used with screen
 printing meshes of the selected category and finer
 35 categories.

1 4. A stencil material according to any preceding
claim, wherein the plastics film support comprises a
material selected from polyesters, polyvinyl chloride,
polycarbonates and polystyrene.

5 5. A stencil material according to any preceding
claim, wherein the plastics film support is substantially
transparent to light in the wavelength range from 350 to
450 nm.

10 6. A stencil material according to any preceding
claim, wherein the plastics film support has a thickness
in the range from 0.2 to 1.3×10^{-1} mm (20 to 130 μ).

15 7. A stencil material according to any preceding
claim, wherein the light-hardenable layer in contact with
the cover sheet comprises polyvinyl pyrrolidone,
pentaerythritol triacrylate, while the underlying light-
hardenable layer comprises polyvinyl alcohol.

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A cross-sectional diagram of a multi-layered structure. The layers are labeled on the right side from top to bottom: 5, 4, 3, 2b, 2a, and 1. Layer 5 is the topmost layer, filled with diagonal hatching. Layer 4 is a thin solid line. Layer 3 is a layer with horizontal dashed lines. Layer 2b is a layer with a grid of small squares. Layer 2a is a layer with small dots. Layer 1 is the bottommost layer, filled with diagonal hatching.

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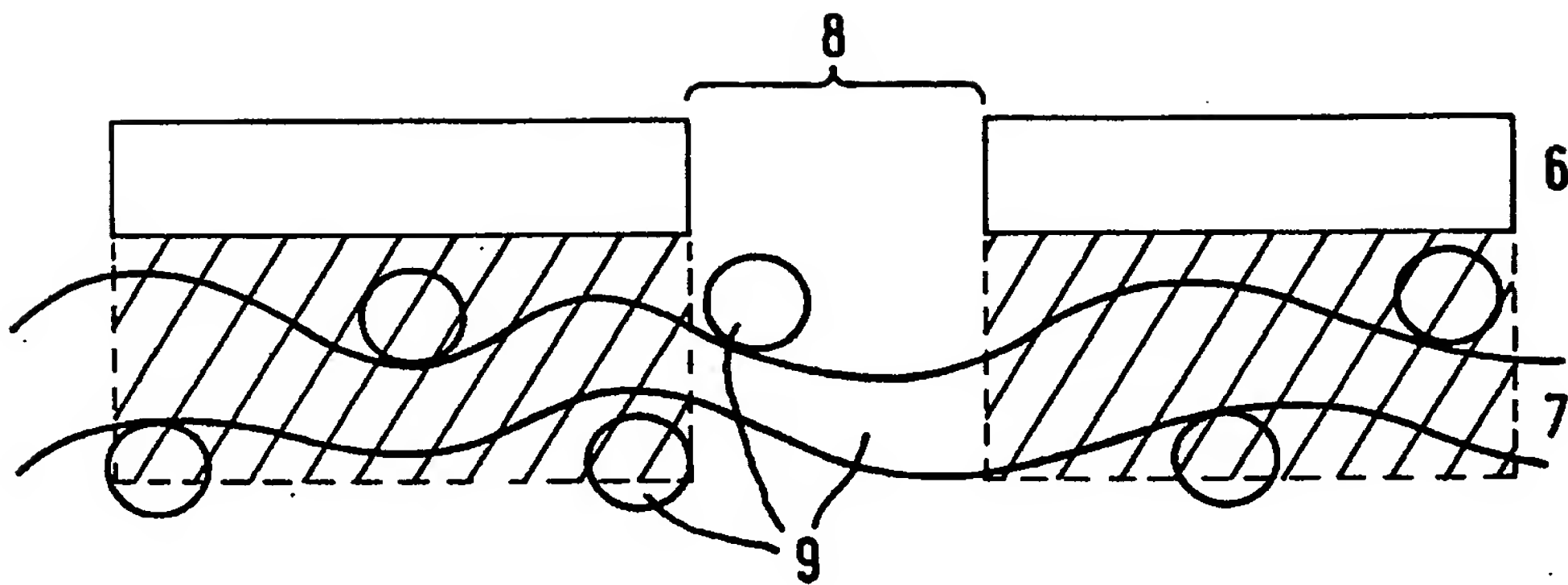


FIG. 3

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